Implementation of High Speed Data Transfer for the SimSat Balloon

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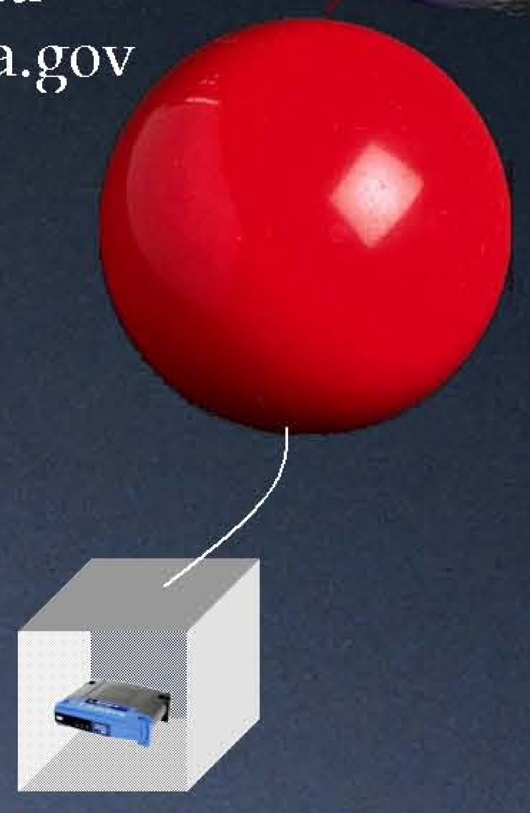


SimSat Background

Designing, building, and launching a satellite payload into space is an extremely costly and lengthy process requiring highly skilled individuals and teams. Unit costs are in excess of tens of millions of dollars and schedules are measured in years.

These costs are well beyond the capacity of high schools but the experience can be well within the reach of the students. The Simulated Satellite, "SimSat", outreach program provides students with an opportunity to get their feet wet with respect to satellite systems by bringing extremely high altitude experimentation into these schools in an affordable manner.

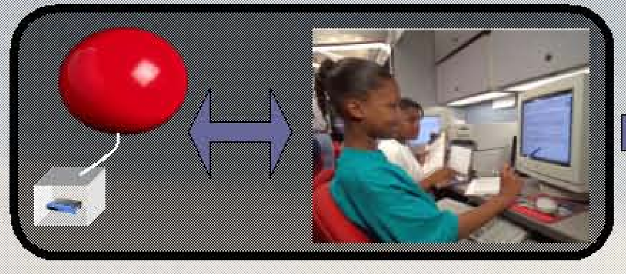
By flying their own experimental payloads to the edge of space (above 99% of the earth's atmosphere) and analyzing real-time telemetry, students are able to have a unique experience similar to that of designing, building, tracking & operating an experiment on board a satellite at a fraction of the cost, schedule and skill level.

SimSat Flight Profile

Students Develop Experiments

Balloon is launched from school

Balloon Flight



Students communicate with and through the balloon throughout flight

Recovery of balloon payload

High Speed Data Transfer for SimSat

As a further development of the existing SimSat platform, high-speed data transfer based on the 802.11b wireless standard are being evaluated, developed and tested as a potential instrument. The 802.11b wireless standard was selected because of recent changes in the FCC regulation of the 2.4 – 2.417 GHz frequency band giving primary access to amateur radio. The 802.11b standard is designed to operate in this band as a secondary user. This means that a wide variety of economical commercial equipment is now available to support traditional tasks of amateur radio.

These data links have a throughput that is in excess of a thousand times faster than the currently implemented system and would allow live video streaming, experiments with high data acquisition rates and communication links between the schools furthering the educational experience of the students.

Individual Contribution

The current project consists of three main stages. The first is analysis work to determine the equipment needed to achieve the objectives, the second is the purchasing of the equipment and the third involves the testing of the system and comparing it to the theoretical results obtained.The work schedule for the project includes:

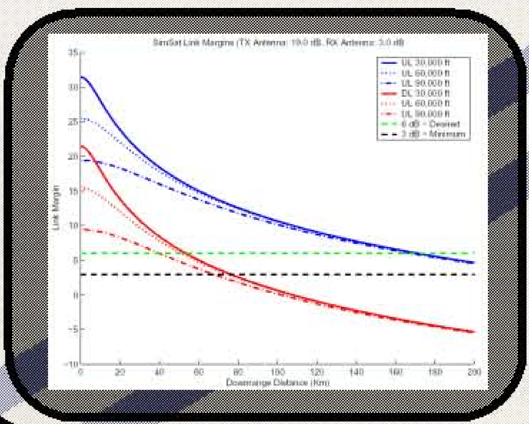
•Characterization of existing equipment	(Completed)
•Determining the desired link margin	(Completed)
•Evaluating new equipment for purchase	(In Progress)
•Purchasing equipment	(In Progress)
•Ground testing of equipment and link	(Awaiting Equipment Arrival)
•Documentation	(In Progress)

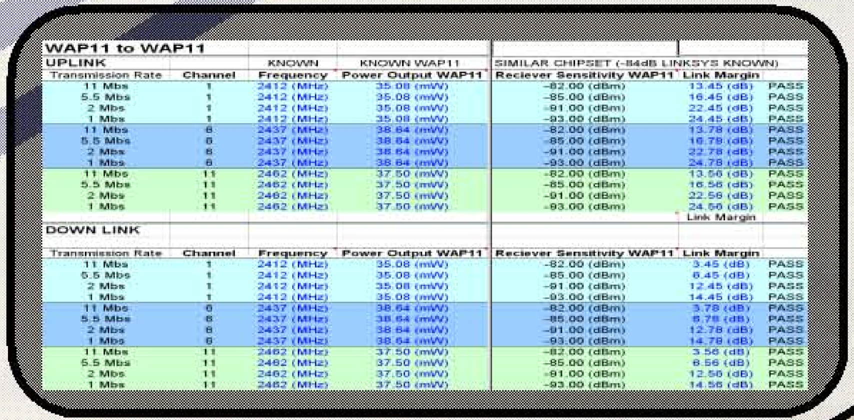
Link Budget Calculations

The bi-directional link budget was calculated using the following parameters which were compiled into an analysis spreadsheet. A number of iterations and variations were then run to determine what sort of connections were possible with equipment that met the unique requirements of the project. These results were used to determine the equipment that would be selected for the experimental test and eventual deployment.

- •Transmitter Power
- •Transmitter Amplifier Gain (Uplink Only)
- •Transmitter Antenna Gain
- •Atmospheric Losses
- •Rain Attenuation
- •Path Losses
- •Cable Attenuation
- •Receiver Sensitivity
- •Receiver Amplifier Gain (Downlink Only)
- •Receiver Antenna Gain

Preliminary Results





Balloon Equipment Design

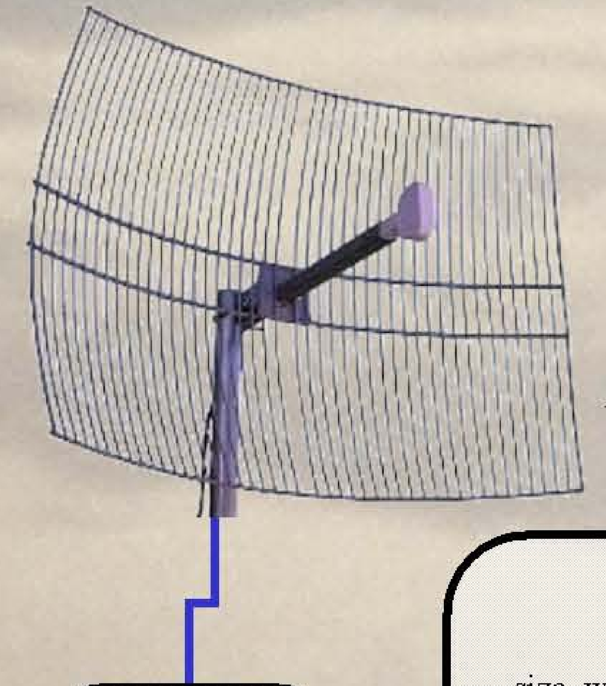
Equipment used on the balloon must be lightweight, of small physical size and consume a minimum amount of power The balloon itself is a latex weather balloon, about six feet in diameter prior to release..

Furthermore, although the payloads are normally recovered, the replacement cost of the equipment must be considered in case the payload is lost. Likewise, the payload must be robust enough to survive an impact with the ground while suspended below a parachute.

Hardware Purchasing

Based on the analysis performed and the existing hardware available purchase orders were issued for the following hardware. This hardware will then be evaluated in the lab and used for development.

•Bi-directional Amplifier	RF LINX 2400L
•Antennas	Pacific Wireless 5.5dB WEP11
	Pacific Wireless InWave
	Pacific Wireless Wire Grid Parabolic
•Cables	LMR-400 N-Type
•Connectors	N to R-TNC & N to RP-SMA
•Test Equipment	YDI and HP Attenuator Kits



High Gain Antenna

Future Directions

Once the ordered equipment has arrived it must be tested and evaluate to ensure that the manufacturer's performance claims are accurate. This will be done in conjunction with GSFC Microwave and Communication Systems Branch, Code 567.

After the hardware performance has been verified, a system evaluation test bed will be developed to test the entire communications system, ground station and payload. In particular this study will evaluate the actual link margins of the system. Simultaneously, a group at Wallops Flight Facility is pursuing studies to ensure the safety of the balloon system.

A series of flight tests of increasing difficulty is planned for the later part of the summer at the Wallops Flight Test Facility. Work on the high speed communication links will continue parallel to this effort. Once both of the preliminary development studies are complete, it is anticipated that the high speed communication link will be tested on its own series of demonstration flights and will eventually become a regular part of the SimSat payload.

Ground Station Design

The ground station is not significantly constrained by size, weight or power. It is also much more accessible than the balloon allowing maintenance, inspection and replacement.

Thus most of the infrastructure requirement, including large antennas and bi-directional amplifiers was placed with the ground station. However, each school that is involved must have its own ground station. It is envisioned that there will be a series of ground station levels each with differing capabilities depending on what the school can support.

School

Class Room

802.11b System

Bi-Directional Amplifier

Visit NASA Explorer Schools at http://explorerschools.nasa.gov/
SimSat Website (GSFC Only) http://simsat.gsfc.nasa.gov/

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